Unit 5
Control in Cells & Organisms

Synoptic essay

Guidance &
Practice Exam Questions
Extract from AQA guidelines
The essay is intended to assess a candidate’s ability to bring together principles and concepts from different areas of biology, express ideas clearly and logically and use appropriate specialist vocabulary. It also provides an opportunity for candidates to demonstrate that they have met the ideals of stretch and challenge required to gain an A* grade.

The marking scheme considers four skill areas
S  Scientific content
B  Breadth of knowledge
R  Relevance
Q  Quality of written communication

In practice, this means that we are looking for
• evidence of knowledge and understanding in keeping with an A-level course of study
• selection of material relevant to the title, and drawn from different areas of the specification
• the ability to present an argument coherently and logically, using appropriate biological language.

You should realise that:

An exceptional essay
• reflects the detail that could be expected from a comprehensive knowledge and understanding of relevant parts of the specification
• is free from fundamental errors
• maintains appropriate depth and accuracy throughout
• includes two or more paragraphs of material that indicates greater depth or breadth of study

A good essay
• reflects the detail that could be expected from a comprehensive knowledge and understanding of relevant parts of the specification
• is free from fundamental errors
• maintains appropriate depth and accuracy throughout

An average essay
• contains a significant amount of material that reflects the detail that could be expected from a knowledge and understanding of relevant parts of the specification. In practice this will amount to about half the essay.
• is likely to reflect limited knowledge of some areas and to be patchy in quality
• demonstrates a good understanding of basic principles but will contain some errors and evidence of misunderstanding

A poor essay
• contains much material which is below the level expected of a candidate who has completed an A-level Biology course although there will be occasional valid points
• Contains fundamental errors reflecting a poor grasp of basic principles and concepts

KEY ADVICE:

It is essential that you PLAN your essay carefully. This will take around 5 minutes. Bullet point or jot down key words, diagrams or construct a mind map. Include a brief introduction and a conclusion to summarize the main points. Remember, that after marking the main body of an essay, examiners will look at the plan for evidence of further possible credit for scientific content.

In the introduction, you should explain the meaning of any ‘key-terms’ mentioned in the title and the outline of the main points to be covered in the essay.

The essay MUST be written as a piece of continuous prose: Whilst writing the essay DO NOT use subheadings, bullet points, i.e. (1) (2) or (a), (b) etc.

Aim to spend 25-30 minutes writing the essay and 5 minutes at the end to read carefully through the essay to make any amendments.

A GOOD TIP is to write on every other line. This allows for easy addition or correction of material.

How do I prepare for the essay?
Below are some examples of essay titles set in previous papers. With each one is a list of areas of the syllabus that can provide material for your essay. If you look at the list after each title you will see that it is a short overview of topics – this is what you need to learn. For the first two examples the short list is followed by a more detailed expanded list to illustrate the possible scientific content. Not all of this needs to be included to gain full marks.

You should prepare for this part of the exam by writing similar short lists for other possible titles. Then, try expanding your lists with examples of what you could include.
### Example 1

**Title:**
The transfer of substances containing carbon between organisms and between organisms and the environment

(25 marks)

**Short list:**

<table>
<thead>
<tr>
<th>Transfer between organisms</th>
<th>Transfer to/from the non-living environment</th>
</tr>
</thead>
<tbody>
<tr>
<td>food chains and feeding relationships</td>
<td>photosynthesis</td>
</tr>
<tr>
<td>carbon cycle</td>
<td>respiration</td>
</tr>
<tr>
<td>nitrogen cycle (parts of)</td>
<td>exchange surfaces</td>
</tr>
<tr>
<td>digestion</td>
<td>(production and) removal of urea</td>
</tr>
<tr>
<td>cell transport</td>
<td>human activities</td>
</tr>
<tr>
<td></td>
<td>agricultural ecosystems</td>
</tr>
</tbody>
</table>

**Expanded list:** [NOTE: it is not necessary, or expected, that you include all these in your essay to gain full marks]

**Transfer between organisms:**

1. Food chains and feeding relationships
   - plants producers
   - idea of food chains as feeding relationships
   - with transfer energy
   - in substances containing carbon

2. Digestion and absorption
   - digestion/hydrolysis of large carbon-containing compounds
   - by enzymes
   - producing small/soluble compounds
   - which can be absorbed

3. Transport of **organic molecules** in and out of cells/across exchange surface
   - organic molecules (including sugars and amino acids) cross cell membranes
   - by facilitated diffusion
   - active transport
   - which requires ATP from respiration
   - involving carrier proteins and/or enzymes
Transfer to/from the non-living environment

(4) Carbon cycle (and relevant parts of nitrogen cycle)
- carbon enters biotic by photosynthesis
- leaves biotic by respiration/combustion
- role of bacteria/fungi as decomposers
- of dead organisms/ faeces/ excretory products/urea

(5) Photosynthesis
- light-independent reaction
- carbon dioxide reacts with ribulose bisphosphate
- glycerate 3-P reduced to sugar
- reduced NADP and ATP from light-dependent reaction
- Calvin cycle

(6) Respiration
- link reaction/Krebs cycle
- oxidation of intermediates
- generation of reduced coenzymes
- loss of carbon dioxide

(7) Exchange surfaces - for carbon dioxide for animals and plants
- large surface area - alveoli - mesophyll cells
- short diffusion pathways - epithelium and endothelium - thin leaves and many stomata
- maintaining diffusion gradient - capillary and respiration - photosynthesis and
- respiration in mesophyll cells (time of day)
- ventilation - breathing - via air spaces in leaf
**Example 2**

**Title:**

Cells are easy to distinguish by their shape. How are the shapes of cells related to their functions?

**Short list:**

- **Epithelial cells in animals**
  - epithelial cells from small intestine
  - epithelial cells of alveoli, gill lamellae

- **Epidermal cells in plants**
  - palisade mesophyll cells
  - stomatal guard cells
  - root hair cells

- **Reproduction**
  - differences between egg and sperm cells

- **Transport of substances in organisms**
  - red blood cells
  - endothelial cells of capillaries
  - xylem vessels
  - phloem sieve cells

- **Nervous coordination**
  - neurones
  - rod and cone cells

- **Muscle**
  - skeletal muscle

**Expanded list:** [NOTE: it is not necessary, or expected, that you include all these in your essay to gain full marks]

**Animals:**

1. Epithelial cells - intestinal, alveolar, kidney tubule, gill lamellae
   - (collectively) large SA
   - flattened - short diffusion pathway
   - folded membrane - larger SA for stated function
   - podocytes - pores for filtrate formation

2. Blood - transport
   - red blood cells
   - biconcave shape - increase SA for oxygen exchange
   - move through capillaries

3. Blood - exchange
   - endothelial cells of capillaries
   - flattened - short diffusion pathway

4. Blood – white cells
   - phagocytes/macrophages
   - ‘amoeboid properties’
   - related to movement into tissues/engulfing e.g. bacteria

5. Nervous system - neurones (and Schwann cells)
   - dendrites - make synaptic connection to other neurones
   - axon/dendron - carry nerve impulses over long distances
   - shapes of relay, motor and sensory
   - related to function
   - myelin sheath - faster transmission of impulses
Example 2 continued

(6) Nervous system - receptors - NB could be other than light
   - cone/rod cells with distinctive 'heads' - containing pigment
   - detect light
   - dendrites to synapse with bipolar/ganglion cell(s)

(7) Muscle
   - elongated - contain rows of sarcomeres
   - leads to contraction in length
   - force generated in particular plane
   - branched in cardiac - give contraction in more than one plane

(8) Ciliated
   - cells lining air passages/oviducts
   - push mucus/eggs along
   - remove trapped microorganisms/towards uterus

(9) Sperm
   - sperm have beating tail/flagellum
   - streamlined shape
   - help sperm to move
   - find egg cell
   - acrosome with (digestive/hydrolytic) enzymes
   - digest way into egg cell

Plants and any other organisms:

(10) Hair cells - of root
    - root - extension of epidermal cell
    - increases SA
    - for absorption of water and mineral ions

(11) Hair cells - of leaf
    - leaf - extension of epidermal cell
    - reduces air flow/traps air near leaf surface
    - reduces water potential gradient for diffusion of water
    - reduces water loss by transpiration

(12) Leaf cells
    - palisade mesophyll are elongated
    - allows more to be packed side by side
    - to absorb maximum amount of light for photosynthesis

(13) Transport in xylem and/or phloem
    - elongated cells
    - xylem vessels no end walls/ phloem sieve cells end plates
    - rows end to end to form 'tubes'
    - no/less resistance to flow

(14) Bacterial cell’s flagellum
    - rotates
    - pushes against external medium
    - moves bacterium
The following examples have short lists only given. These are not necessarily exhaustive and you may well think of other topics to include. Work on these to produce expanded lists and then final essays.

Example 3

Title: Transfers through ecosystems.

Short list:
1. Photosynthesis – energy transfer
2. Respiration – energy transfer
3. Carbon cycle
4. Nitrogen cycle
5. Food chains
6. Ecological pyramids
7. Pesticide toxicity/bioaccumulation
8. Eutrophication
9. Digestion and absorption
10. Transfer of genetic material
11. Water cycle

Example 4

Title: Movements inside cells

Short list:
1. Plasma membranes and movement across
2. Protein synthesis
3. Movement through ER and Golgi
4. Cell division and chromosome movement
5. Water movement in plants/xylem
6. Translocation
7. Neurones and synaptic vesicles
8. Actin and myosin
9. DNA replication and mutation
10. Electron transport chains
11. Molecular/atomic/ionic movement

Example 5

Title: The part played by the movement of substances across cell membranes in the functioning of organs and organ systems.

Short list:
1. Plasma membranes and movement across
2. Gaseous exchange system/ lungs
3. Digestive system/small intestine
4. Blood vascular system
5. Transpiration/root/stem
6. Mass flow/leaf/stem
7. Nervous system/eye
8. Excretory system/ kidney
9. Muscle systems
10. Liver, blood glucose
11. Root mineral ions
10. Lungs
Example 6

Title: The part played by enzymes in the functioning of different cells, tissues and organs.

Short list:
1. Action of enzymes
2. Enzyme properties
3. Extracellular digestion
4. Nutrient cycles
5. Digestion in humans
6. Replication of DNA
7. Protein and enzyme synthesis
8. Metabolic pathways
9. Mutations
10. Coenzymes and enzyme action
11. Homeostasis
12. Neuron/synapse
13. Muscle contraction
14. Pesticide toxicity

NOTE: SHORT LISTS CAN BE ADAPTED TO A RANGE OF TITLES
For example, some of this list will also be relevant if the title is: ‘The central role of proteins in living organisms’
You would need to add the role of proteins in such areas as structure [e.g. collagen], transport [e.g. haemoglobin] and homeostasis [e.g. hormones such as insulin]
You would need to remove the excess detail about enzymes such as their role in nutrient cycles, DNA replication and extracellular digestion.

Example 7

Title: Using DNA in science and technology (25 marks)

Short list:
- DNA and classification
  - Structure of DNA
  - Differences in DNA lead to genetic diversity
  - Comparison of DNA base sequences
  - DNA hybridisation
  - Genetic engineering and making useful substances
    - Plasmids
    - The use of recombinant DNA to produce transformed organisms that benefit humans
  - Other uses of DNA
    - Cell cycle and treatment of cancer
    - Gene therapy
    - Medical diagnosis and the treatment of human disease
    - The use of DNA probes to screen patients for clinically important genes

Example 8

Title: A cycle is a biological pathway or process in which the end product of one cycle becomes the starting point for the next cycle. Write an essay about cycles in biology (25 marks)

Short list:
- Ecological cycles
  - Nutrient cycles
  - Carbon cycle
  - Nitrogen cycle
- Biochemical cycles
  - Enzyme action
  - Synthesis of ATP from ADP
  - Light-independent reaction [Calvin cycle]
  - The Krebs cycle
- Physiological and genetic cycles
  - The mechanism of breathing
  - The cardiac cycle
  - The cell cycle
  - Muscle contraction
  - Oestrous cycle
Example 9
Title:
Carbon dioxide may affect organisms directly or indirectly. Describe and explain these effects.

Short list:
Carbon dioxide affects the physiology of organisms
- Pulmonary ventilation and the mechanism of breathing
- Light-independent reaction of photosynthesis. Limiting factors
- Role of chemoreceptors in controlling heart rate

The direct effects of increasing carbon dioxide concentration
- Respiration, photosynthesis and human activity giving rise to short-term fluctuations and long-term change.
- Yield of crop plants
- Carbon cycle

Indirect effects of increasing carbon dioxide concentration
- Role of carbon dioxide in producing global warming;
- Life cycles and number of insect pests;
- Distribution of animals and plants;
- Effect of pH on enzymes;

Example 10
Title
The causes of disease in humans.

Short list:
Pathogens
- Pathogens include bacteria, viruses and fungi
- Pathogens cause disease by damaging cells and producing toxins
- Cholera bacteria produce toxins resulting in diarrhoea
- Symptoms and transmission of pulmonary tuberculosis
- Horizontal gene transmission and MRSA

Lifestyle
- Risk factors associated with cancer and coronary heart disease
- The effects of fibrosis, asthma and emphysema on lung function
- The biological basis of heart disease

Genetics
- Differences in bases may lead to non-functional enzymes
- Relationship between the cell cycle and cancer
- Proto-oncogenes and tumour suppressor genes
- Gene mutations

Other possible titles:
- The importance of water to living organisms
- The central role of DNA in organisms
- The process of diffusion & its importance in living organisms.
- ATP and its role in living organisms.
- How bacteria affect human lives.
- Negative feedback and its importance in biology
- Condensation and hydrolysis and their importance in biology.
- Inorganic ions include those of sodium, phosphorus and hydrogen. Describe how these and other inorganic ions are used in living organism.
- Describe how nitrogen-containing substances are taken into, and metabolised in, animals and plants.
- Why offspring produced by the same parents look different in appearance.
## Marking criteria

These are the criteria used by the examiners when awarding marks

### Scientific content of the essay [max 16 marks]

<table>
<thead>
<tr>
<th>Category</th>
<th>Mark</th>
<th>Scientific Content Descriptor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exceptional</td>
<td>16</td>
<td>Material accurate and of a high standard throughout, reflecting a sound understanding of the principles involved and a knowledge of factual detail fully in keeping with a programme of A-level study. In addition, there are some significant references to material that indicates greater depth or breadth of study.</td>
</tr>
<tr>
<td></td>
<td>14</td>
<td></td>
</tr>
<tr>
<td>Good</td>
<td>12</td>
<td>Most of the material is of a high standard reflecting a sound understanding of the principles involved and a knowledge of factual detail generally in keeping with an A-level course of study. Material accurate and free from fundamental errors, but there may be minor errors that detract from the overall accuracy.</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Average</td>
<td>8</td>
<td>A significant amount of the content is of appropriate depth. Shows a sound understanding of most of the principles involved and knowledge of factual detail generally in keeping with a programme of A-level study. Most of the content is accurate with few fundamental errors.</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Poor</td>
<td>4</td>
<td>Material presented is largely superficial with only occasional content of appropriate depth. Shows some understanding of some of the basic principles involved. If greater depth of knowledge is demonstrated, then there are fundamental errors.</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Unacceptable</td>
<td>0</td>
<td>Such material as is relevant is both superficial and inaccurate. Fails to demonstrate evidence of knowledge in keeping with a programme of A-level study.</td>
</tr>
</tbody>
</table>

### Breadth of the essay [max 3 marks]

<table>
<thead>
<tr>
<th>Mark</th>
<th>Breadth Descriptor</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>A balanced account making reference to most of the areas that might realistically be covered in an A-level course of study</td>
</tr>
<tr>
<td>2</td>
<td>A number of aspects covered but a lack of balance. Some topics essential to an understanding at this level not covered.</td>
</tr>
<tr>
<td>1</td>
<td>Unbalanced account with almost all material based on a single aspect</td>
</tr>
<tr>
<td>0</td>
<td>Material entirely irrelevant</td>
</tr>
</tbody>
</table>

### Relevance of essay [max 3 marks]

<table>
<thead>
<tr>
<th>Mark</th>
<th>Relevance Descriptor</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>All material presented is clearly relevant to the title. Allowance should be made for use of marginally relevant introductory material</td>
</tr>
<tr>
<td>2</td>
<td>Material generally selected in support of title but some of the main content of the essay is only of marginal importance.</td>
</tr>
<tr>
<td>1</td>
<td>Some attempt made to relate material to the title but considerable amounts largely irrelevant.</td>
</tr>
<tr>
<td>0</td>
<td>Material entirely irrelevant or too limited in quantity to judge.</td>
</tr>
</tbody>
</table>

### Quality of written communication [max 3 marks]

<table>
<thead>
<tr>
<th>Mark</th>
<th>Quality of written communication Descriptor</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>Material is logically presented in clear English. Technical terminology has been used effectively and accurately throughout.</td>
</tr>
<tr>
<td>2</td>
<td>Account is logical and generally presented in clear scientific English. Technical terminology has been used effectively and is usually accurate.</td>
</tr>
<tr>
<td>1</td>
<td>The essay is generally constructed poorly and often fails to use an appropriate scientific style and terminology to express ideas.</td>
</tr>
<tr>
<td>0</td>
<td>Material entirely irrelevant or too limited in quantity to judge.</td>
</tr>
</tbody>
</table>